ENERGY EFFICIENCY

Key to Survival in the 21st Century

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We can’t predict the future, but …

If our civilization is to survive, we cannot stray far from the following scenario ...

THE LOGIC

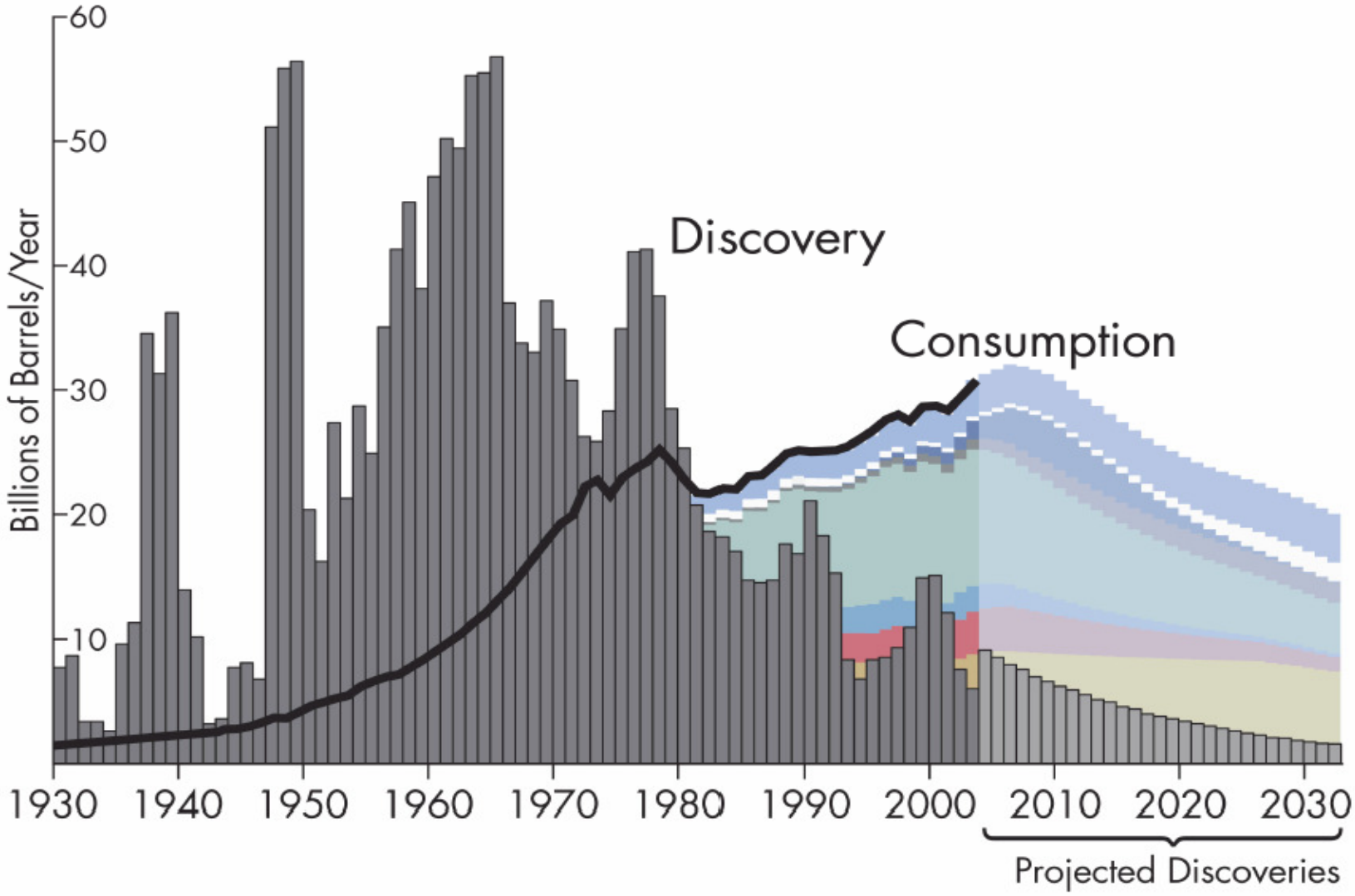
(1) We are rapidly exhausting fossil fuels.

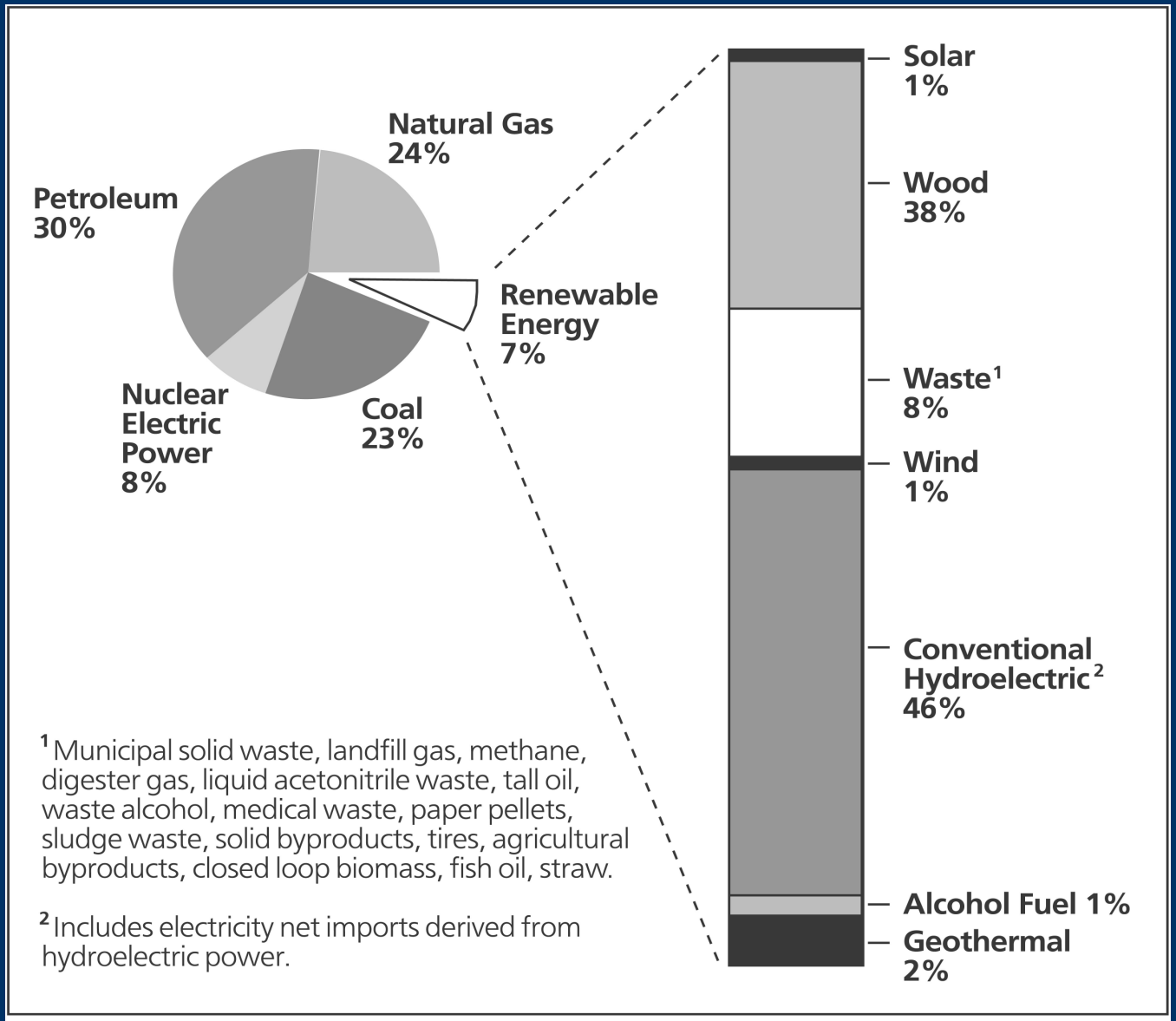
(2) So, our future must depend on non-fossil ("renewable" and other) energy sources.

(3) But, replacement sources probably can supply only a fraction of current usage.

(4) Therefore, we must maximize energy efficiency and energy conservation.

Peak Oil – The Growing Gap





Renewable energy as share of U.S. energy comsumption, 2000
(Source: U.S. Energy Information Administration)

UNLIKELY SALVATION

- **Hydrogen fusion**
- **Oil shale / tar sands**
- **Deep hydrocarbons**
  (methane hydrates, oil well refilling, etc.)
- **Other …**
  (As a situation becomes desperate, people increasingly seek and believe in miracles.)

PURPOSE
OF THIS PLAN

To enable the United States to thrive in a world of expensive and scarce energy by using energy efficiency and energy conservation.

OUTLINE
OF THE PLAN

1. **SHOW where energy is used and where it is wasted.**
2. **ESTIMATE the savings potential within each usage sector.**
3. **RECOMMEND the actions needed in each sector.**

- **This plan focuses on the TRANSITION PERIOD, which is the interval during which we must prepare to live within the limitations of sustainable sources.**

- **The transition to energy efficiency began in 1973, with a flood of new knowledge and ideas. U.S. efficiency advanced in several areas.**

- **Since the mid-1980's, progress has slowed to a halt in all sectors. The drive toward extreme efficiency must be restarted and managed effectively.**

The good news: a very large part of present U.S. energy use is "fat" that can be eliminated without harm to our quality of life.

But, …

NO TIME TO WASTE

(1) It takes energy to develop alternative energy sources.

(2) It takes energy to achieve energy efficiency.

So, we must make the transition while energy is still affordable.

Efficiency must stay ahead of shortages ...

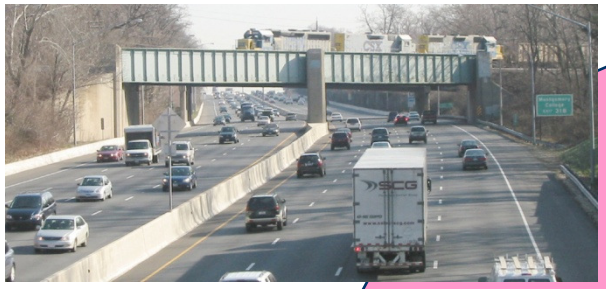
One year ahead of the curve allows a soft landing.

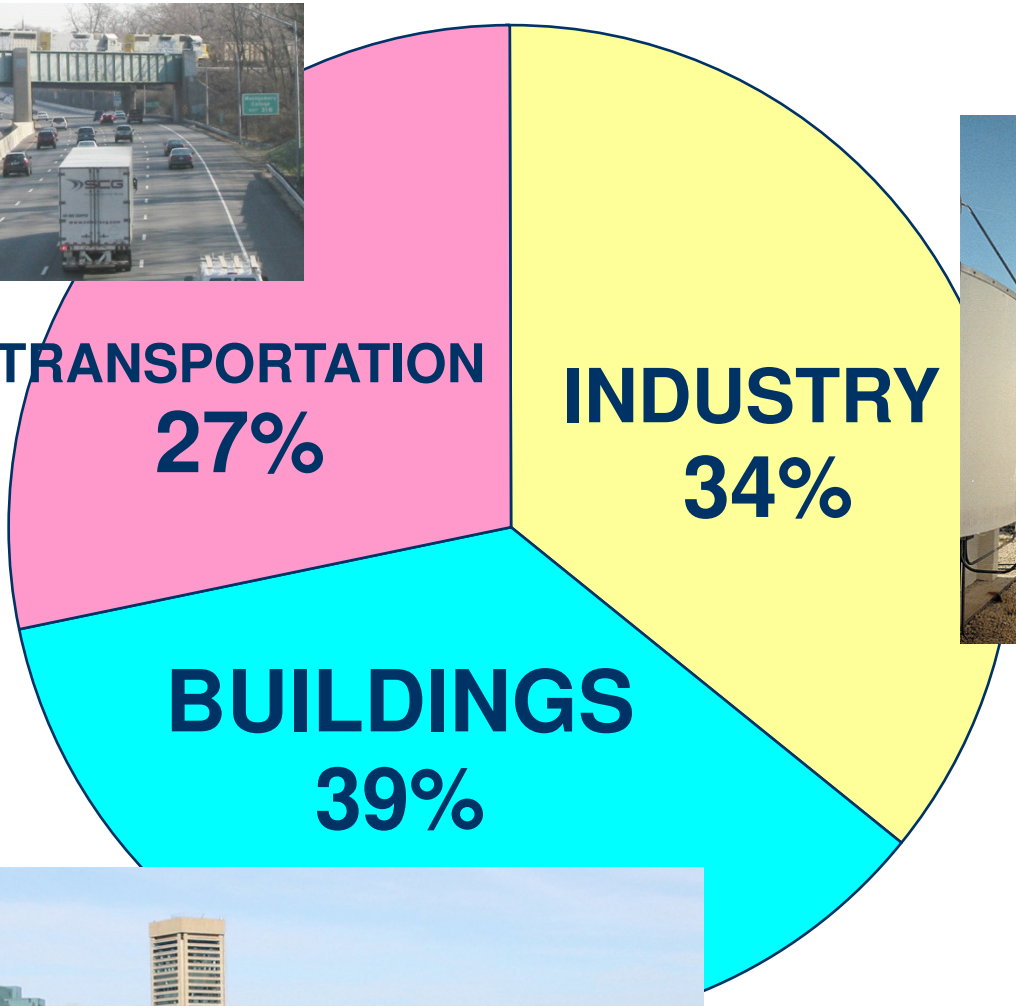
One year behind the curve brings catastrophe.

NO MAGIC BULLET

- Achieving energy efficiency requires many diverse actions.
- Each action requires its own participants, techniques, and economics.
- Each action has obstacles that must be overcome.

U.S. ENERGY CONSUMPTION





For Each Energy Source & Conservation Measure, Know ...

- How It Works
- Energy Available or Saved
- Energy Return Ratio
- Where It Can Be Used
- Most Efficient Scale
- Adverse Environmental Effects & Other Liabilities
- How Close to Reality Is It?

27% of Total U.S. Energy

TRANSPORTATION
SECTOR CHARACTERISTICS (I)

- Most transportation is fueled by OIL.
- As a nation, we drive to work. This makes the U.S. very vulnerable to oil scarcity or to high oil price.
- Transportation has very large potential for reducing energy consumption.
- No new technology is needed.

TRANSPORTATION
SECTOR CHARACTERISTICS (II)

- The needed changes are remarkably free of external obstacles. Most actions can be initiated individually or by market forces.
- The biggest need is for awareness of appropriate action.
- The biggest obstacle is distraction by ineffective responses.

TRANSPORTATION
Main Transition Strategies

(1) Minimize transportation.
(VERY LARGE potential)

(2) Improve vehicle fuel economy.
(LARGE potential)

(3) Shift from petroleum fuels.
(SMALL potential)

MINIMIZE TRANSPORTATION

- **Minimize commuting to work and school. (MAJOR SAVING)**
- **Minimize repetitive non-commuting driving. (MAJOR SAVING)**
- **Minimize long-distance occasional travel. (MINOR SAVING)**
- **Minimize freight transportation. (MODERATE SAVING)**

MINIMIZE TRANSPORTATION

Minimize Commuting

- Commuting is entirely unproductive.
- It wastes vast amounts of fuel and vehicle manufacturing energy.
- Everyone hates it.
- The solution is to live near work, or to work near home.
- Action is individual, entirely voluntary, and feasible immediately.

Benefits of Avoiding Commuting

- Huge increase of human productivity
- Large saving of household costs for vehicles, maintenance, and fuel
- Reduced accident death and injury
- Reduced respiratory disease
- Reduced orthopedic injury
- Improved physical fitness

MINIMIZE TRANSPORTATION

Avoid Repetitive Non-Commuting Driving

- Includes grocery shopping, children's activities, dining out, etc.
- The solution is a return to small, self-contained communities, perhaps within larger cities.
- Action is voluntary, but it requires a market to motivate development of highly attractive communities.

We know how to do this, …

U.S. communities will return to an updated version of earlier self-contained community life.

European "walk around" towns are admired by Americans.

The energy crisis motivates us to live as we would prefer.

MINIMIZE TRANSPORTATION

Minimize Long-Range Occasional Travel

- Includes business and personal travel (e.g., attending conferences, travel to theme parks).
- Such travel is highly discretionary. Alternatives are available or they will become available.
- High cost of travel will motivate change without special action.

Footnote:

A rational approach to energy efficiency causes some major problems to solve themselves, or to require greatly reduced effort.

MINIMIZE TRANSPORTATION

Minimize Freight Transportation

- The freight system is already efficient on a ton-mile basis.
- Energy savings will come primarily from reduced quantity of freight and reduced shipping distances.
- Returning to a culture of thrift will result in goods that are more durable and better utilized.

IMPROVE VEHICLE FUEL ECONOMY

- Economy will come mostly from reduced vehicle weight and drag, not from new types of engines.
- Very-high-mileage (ca. 100 MPG) cars can be inexpensive, safe, and comfortable, but small.
- EPA fuel mileage ratings are valuable, CAFE standards are not.

SHIFT FROM PETROLEUM FUELS

- Plan for rational use of electric vehicles for short-range driving.
- But, coal-derived substitutes for gasoline and diesel fuel are a panic measure with severe adverse effects.

These Won't Help Much

- Mass transit
- Hybrid cars
- Hydrogen economy
- Coal-derived fuels
- Ethanol
- Telecommuting
- Other …

Summarizing transportation, …

The most important action is to organize our travel and living arrangements in ways that are desirable in themselves.

If that is done, everything else will fall into place with a minimum of government action.

39% of Total U.S. Energy

BUILDINGS

SECTOR CHARACTERISTICS (I)

- Housing uses 21% of total U.S. energy, non-residential buildings use 18%.
- Buildings use electricity, natural gas, (much less) oil and propane.
- Both residential and non-residential buildings use about 5 times more energy than is economically reasonable, on average.

BUILDINGS

SECTOR CHARACTERISTICS (II)

- NEW buildings offer major opportunity to reduce energy use. The cost of high efficiency is minor.
- EXISTING buildings offer limited opportunity for saving energy. Physical changes are expensive.
- No new technology is needed, but a few new items are desirable.

Two Different Worlds

- **HOUSING and NON-RESIDENTIAL buildings are separate worlds. The people, education, licensing requirements, design procedures, infrastructure, etc. are all different.**
- **The technical end results are the same.**

HOUSING
Achieving Super-Efficiency

1. INSULATION
2. WINDOWS
3. TARGET ENERGY USE
4. APPLIANCES

Housing Efficiency: INSULATION

1. Radically increase the amount of insulation.
2. Distribute insulation intelligently.
3. Adopt good insulation practices.
4. Exploit the opportunity to radically improve the structure.


FIBER GLASS
FIBER GLASS
FIBER GLASS

Housing Efficiency: WINDOWS

1. Avoid excess glass. It is the major cause of both heating and cooling costs.
2. Locate glass for efficient heating, cooling, view, and daylighting.
3. Use external shading to prevent any direct sunlight through glass during warm weather.

Housing Efficiency: TARGET ENERGY USE

1. You live in one room at a time. So, heat and cool one room at a time. Automate this.
2. Cluster and isolate rooms for efficiency and convenience.
3. Select heating and cooling equipment for efficient isolation and low fuel cost.

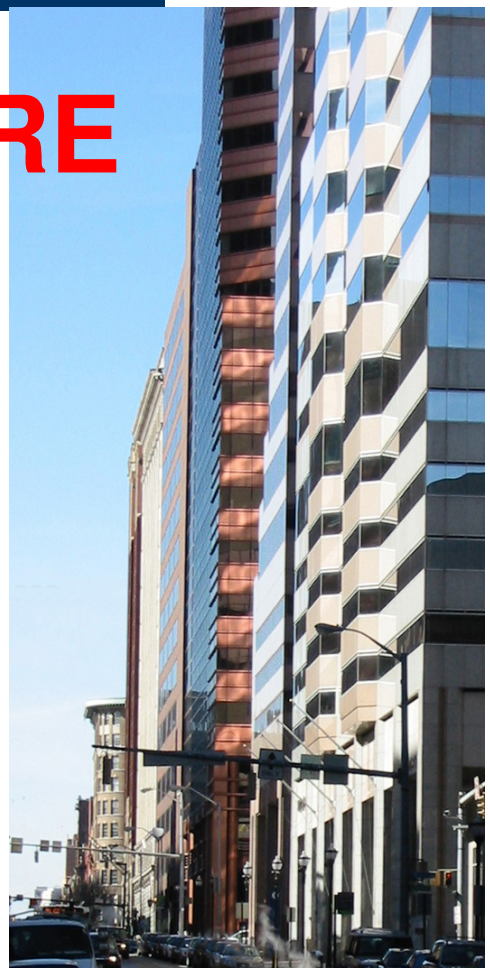
Housing Efficiency: APPLIANCES

1. This is easy. Select the most efficient practical models of all appliances.

COMMERCIAL BUILDINGS

Achieving Super-Efficiency

1. EXTERIOR STRUCTURE
2. HEATING, COOLING & VENTILATION
3. LIGHTING



Commercial Buildings Efficiency: EXTERIOR

1. Architect is the responsible party.
2. No rational doctrine of efficient design presently exists in the architect profession.
3. Efficient design requires a competent combination of insulation, glazing, and shading.

Commercial Buildings Efficiency: HVAC

1. **Mechanical engineer is the responsible party.**
2. **Still struggling to design efficient systems.** **(Revolution in HVAC design was introduced at Clima 2005, Lausanne.)**
3. **Good HVAC design fixes comfort and health problems, and minimizes terrorism threat.**

Commercial Buildings Efficiency: LIGHTING

1. Lighting is a big energy user in commercial buildings.
2. No profession has responsibility.
3. Effective task lighting needs to be developed and introduced, along with better control of lighting using present methods.

BUILDINGS
Vision of the Future (I)

- Building types remain unchanged.
- Internal layout and usage are largely unaffected.
- Exterior appearance is different.
- Health problems are minimized.
- Comfort problems are minimized.

BUILDINGS

Vision of the Future (II)

- Fire resistance is improved.
- Buildings last longer.
- Large buildings are much more resistant to biological and chemical terrorism.
- Design is highly standardized.

OBSTACLES
to Buildings Efficiency (I)

- Expectations for efficiency are much too low. (The realistic goal is 500% increase in efficiency.)
- The architect profession resists energy efficiency for competitive and social reasons.

OBSTACLES
to Buildings Efficiency (II)

- Competent professional education in building design does not exist.
- Organized knowledge of building efficiency is spreading too slowly.
- Advocacy of energy efficiency by organizations is ineffectual or counterproductive.

DISTRACTIONS
from Buildings Efficiency

- "Zero energy buildings" (buildings as platforms for renewable energy generators)
- "Green buildings" (design by nostrums)
- Short-list conservation ("low fruit", "no cost", etc.)

Building Owner: “Mr. Wulfinghoff, please give us a ‘short list’ of ways to make buildings efficient.”

Wulfinghoff: “If I could do that, I wouldn’t have spent 20 years writing a book about energy efficiency that weighs 8 pounds.”

OVERCOMING the OBSTACLES

- **Enforcement of energy efficiency in the building codes. Only then is it possible to educate designers and builders about energy efficiency.**
- **Litigation against designers and builders who ignore efficiency codes and standards of care.**
- **Investor and owner demand for rationally efficient buildings.**

OVERCOMING the OBSTACLES
Energy Efficiency Codes

- Level the economic playing field, making investors willing to undertake the additional costs of efficient buildings.
- Create a constituency for energy efficiency.
- Educate existing designers.
- Provide a syllabus for training future designers.
- Standardize building design, making performance predictable and lowering cost.

OVERCOMING the OBSTACLES
Litigation & Prosecution

- Every inefficient building designed since the 1970's involves a tort, a crime, or both.
- The evidence trail is overt and easily accessible.
- Culpability is clear. Efficiency codes, Executive Orders, contractual requirements, and standards of care were violated at the time of design.

OVERCOMING the OBSTACLES
Investor and Owner Appeal

- Buildings are the world's largest durable commodity market.
- The entire stock of existing buildings is obsolete, and it must be either replaced or upgraded.
- The financial rate of return for optimized new buildings is very high.

Summarizing buildings, …

Buildings comprise the largest part of civilization's potential for surviving with limited energy.

The obstacles to efficiency are professional, not technical.

Both owner/investor pressure and aggressive policing are needed.

34% of Total U.S. Energy

INDUSTRY Sector

INDUSTRY

SECTOR CHARACTERISTICS

- Industry uses electricity, natural gas, (much less) oil and propane.
- Much energy use is process-specific.
- Energy saving potential is moderate.
- Major savings have already been achieved, but progress has halted.
- Better technology is a limited issue.

INDUSTRY

Main Transition Strategies

- Increase the life of products.
- Optimize recycling.
- Improve industrial processes, where possible.
- Educate managers to integrate efficiency into plant management.

Summarizing industry, …

The largest reductions of industrial energy consumption will come from returning to a culture of thrift.

Improving process efficiency requires engineering advances.

Improving non-process efficiency requires a better doctrine of plant management.

The U.S. and the WORLD

- The rest of the world faces the same energy challenge as the U.S.
- The U.S. cannot solve its energy problem individually. The solution must be worldwide.
- The U.S. can compete for remaining fossil fuels only by paying the world price, while using diplomacy to protect access to the world market.

21st century energy SUPPLY:

By mid-century, total energy supply at viable prices may be down to 20% of current supply.

This estimate is very approximate. Reasonable scenarios could make it higher or lower.

21st century energy NEED:

Extreme efficiency may allow society to function with about 20% of current consumption.

This estimate is more reliable technically.
The main uncertainty is population.

“20%” for both estimates ...

It’s going to be a close call.

The world on the other side of the transition will be a different place. If the transition is successful, the U.S. will still have freedom, prosperity, and the pursuit of happiness.

But, some habits and activities will be gone, replaced by new ones. Old strengths and wisdom will be rediscovered.

The United States is distinguished by its adaptability and resourcefulness. These characteristics will be essential for a successful transition to the second half of this century.